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PLANT REQUIREMENTS FOR MANUFACTURE OF METAL SPINNING PRODUCTS

TECHNICAL AIDS BRANCH

INTERNATIONAL COOPERATION ADMINISTRATION

Washington, D. C.

FOREWORD

This brochure is one of a series of reports resulting from overseas technical inquiries on factory or commercial establishments, operation, management, and engineering. The report is designed to provide only a general picture of the factors that must be considered in establishing and operating a factory of this type. In most cases, plans for actual installations will require expert engineering and financial advice in order to meet specific local conditions.

Mention of the name of any firm, product, or process in this report is not to be considered a recommendation or an endorsement by the International Cooperation Administration, but merely a citation that is typical in its field.

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For further information and assistance, contact should be made with the local Productivity Center, Industrial Institute, Servicio, or United States Operations Mission.

Code Number
52

Metal Spinning

INQUIRY: Information is requested on the technique used in the manufacture of metal shapes formed by means of spinning and its advantages.

INFORMATION SUBMITTED:

Metal spinning is a skillful art of folding a flat piece of pliable thin sheet metal over the contours of a pattern. Folding is done by applying a specific spinning tool either by hand or by mechanical means to the fast-rotating sheet metal. The metal may be ferrous or non-ferrous. The tool can be simple or complicated, depending on the shape of the chuck.

Products Made by Spinning

Various kinds of products, such as bowls, seals, funnels, shields, radar antennas, centrifuge discs, television picture tube shells, blower housings, turbine chambers, kitchen utensils, vacuum cleaner parts, domes, venturi tubes, aircraft assemblies, microphone parts, speaker horns, parabolic reflectors, and thousands of other parts may be assembled into complicated parts by brazing, welding, or riveting.

Present-day spinning techniques permit many ways of fashioning sheet metal shapes, and is favored by metal working shops in the following cases: (a) when other forming methods like pressing or drawing would make shaping impractical, or even impossible; (b) when the production of parts would be much more expensive if pressing or drawing; (c) when the number of the finished workpieces required is fairly small as compared with the large quantity is possible with pressing and/or drawing operations; (d) when the low cost of tooling is an important factor, as in case of limited production or when making only a few parts for experimental purposes; (e) when the required accuracy of the finished workpieces is not too exacting; (f) when metal can be used which allows a free flow of the molecules during the spinning operations; (g) when delivery must be made on short notice; (h) when it is not practical or possible to provide internal support for the metal while it is being narrowed down on a press, as is the case when certain shapes like kettles, tubs, bottle shapes, and similar articles make pressing or deep drawing operations difficult, (spinning is preferable here, since a sectional block or an internal roll is sufficient to provide the support necessary during spinning); (i) when components for experimental purposes are subject to continuous change and the parts cannot be built on a production basis; and, finally, (j) when an already existing metal working shop desires to produce certain shapes, such as shown on the tool and process chart, but objects to getting expensive metal drawing or punch and die equipment.

The Art of Spinning

In spinning, each metal (steel, stainless, aluminum, brass, copper, etc.) requires its own spinning technique and different tools and tool movements depending on the flow characteristics of each metal. The spinning is an art, which must be learned through the constant use of tools built to the spinner's specifications and the special "sense of feel" he acquires through years of practice.

Materials Used in Spinning

Certain aluminum sheets, soft steel sheets, stainless steel sheets, nickel, monel, bronze, copper, and brass sheets adapted to spinning can be spun cold up to a certain thickness.

When thicker sheets must be spun they are worked under heat to aid in forming the heavy metals. The heat is applied with an open oxyacetylene flame directed at the metal while it is on the spin lathe.

Tools Used in Spinning

Spinning tools are made to fit the job and the spinner's preference. While some tools can be procured from the manufacturers of the fast-spinning lathes, the majority of them are made to order in accordance with the individual specifications of the spinner, whose knowledge of spinning and experience with the various metals help him in determining the shape of the tools he prefers to use.

Some tools are simple hardwood sticks, others are of metal and very elaborately shaped for special work, each designed by the spinner who is to use it. In most cases the size and shape of each tool depends on the way an experienced spinner prefers to hold it, the pressure he likes to exert on the metal while spinning it, and the way he swings his tools with his arm and body during the spinning operations.

Some of the standard tools obtainable on the market are shown on the tool and process chart. They are known to spinners by their trade names, such as: the No. 1 tool is known as the round-nose tool; No. 2, the raising-up tool; No. 3, the nob-raiser; No. 4, the turnover tool; No. 5, the groover; No. 6, the polishing tool. A roller tool and a cutting-off tool are also shown.

Spinning Lathes

These are similar in may respects to lathes used for wood working, but of heavier construction. A larger headstock is necessary because of the heavy pressure exerted upon it by the follower. Some large spinning shops use vertical spindle spinning machines for thick sheet metal shaping.

Noteworthy improvements are being reported in the development of the spinning lathe and spinning methods. Whereas a short time ago, only symmetrical articles generated around their own axis could be spun, some shops can now spin into square, hexagonal, octagonal, and even eccentric shapes. The lathe in this case is equipped with a tool holder which works on the principle of the reciprocating movement, guiding the spinning tool moves in and out, making it follow the angles or the shape of an eccentric block.

How the Sheets are Formed

The sheet metal is formed over or inside of the so-called blocks, also known as chucks or mandrels, while they revolve in the fast spin lathe. Their contours determine the shape of the finished article. Numerous contours are illustrated in figure 7, showing the spinning tool forcing the metal against the chuck on the outside, or on the inside, as the case may be, depending on the design.

In general practice, the chucks are made of laminated hardwood, but in some instances cast light metal or soft steel materials machined to the desired shape of the finished product are used. This is the case when increased accuracy of the finished product is desired, because wood chucks have the tendency to yield under extra heavy tool pressures. Wood, however, is still the preferred material, especially when short runs are planned and where the spinner has sufficient experience in calculating accurately the springback quality of the wood.

In some cases these wooden blocks are covered on their wearing surfaces and vital sections with inserted metal plates, as shown in figure 8. These not only increase the life of the blocks, but make possible the use of wooden blocks instead of metal blocks in the larger sizes.

Sectional Type Chucks--The sectional type chuck, as shown in figure 9, is a spinning form made up by accurately fitted units which can be disassembled by removing a center or key section. This type is used principally for spinning a cylindrical shape having a relatively large body and narrow throat. A bottle, flask, or ampoule would be indicative of this type of spinning. The metal sheet is placed on the sectional chuck and spun in the same manner as any other shape. In order to remove the chuck from the spun article, the center or key section is withdrawn permitting the outer sections of the chuck inside the shape to collapse. The pieces are then removed through the narrow throat opening. The sectional type chuck is a complex unit and must be precision made with each segment accurately fitted. No space between sections can be allowed because it would automatically show in the surface of the spun part.

Off-Center Form Rolls -- Other type of spun work is done on an off-center form roll, designed for bulging and necking operations common to vaselike shapes. In some instances, this may not prove as efficient as the sectional or collapsible chuck because it does not give the same internal support as the sectional chuck. This type form roll is illustrated in figure 10.

In some instances a workpiece may require more than one spinning operation. In such progressive spinning only the last chuck is made to correspond with the final shape desired. Others are used simply to preform the workpiece. Figure 11 shows a shell, drawn first on a press and finished on a spinning lathe

by necking, trimming and fine beading. Spun parts, as shown in figure 12 may be assembled into complicated shapes by brazing.

For quantity and quality production the metal chuck is preferable, since highly polished steel chucks produce smooth surfaces and are most economical for products to be buffed or given a similar finish.

When the workpiece is usually large or the thickness of the metal makes hand spinning difficult, the spinning tool is mechanically applied against the work. It is set so that it travels automatically back and forth the full length of the workpiece. Compressed air advances the tool step by step as it presses the metal tightly against the chuck. In work of this type, the tool is either a highly polished steel shoe, or it consists of idler rolls which operate against the metal in opposite directions, substituting for the usual type of hand forming tool. Automatic operation is very often applied as a first spinning operation on a workpiece, later shaped into the final form on a press. This combination of spinning and pressing often eliminates an otherwise expensive annealing operation.

Tube Spinning -- This is still another application of the art of spinning. Tubes may be completely sealed, or tapered, or the tubes may be flanged as shown in figure 13. If they are of heavy metal, hot spinning is done with heavy rollers applied by force.

Experience Required:

Spinning metal by hand is a craft that requires unusual skill and experience on the part of the operator or spinner. In this process the shape of a flat or preformed circular piece of sheet metal is changed to that of the block by making the metal flow against the surfaces of the block with the minimum of tool contact. This requires experience, otherwise too much stroking of the metal may easily result in work hardening of the sheet metal or in undesirable thinning that would ruin the workpiece. The metal must be drawn by the skill of the spinner from the unformed portion of the sheet metal blank, and forced into the sections of the block. The spinner relies entirely on his skill and experience to do this successfully and maintain the desired uniform thickness in the spun part.

Selection of the Machine:

From the various types and sizes of spinning lathes produced today, a selection was made which enables a medium size shop to produce the products described on the first page.

(a) One light spinning lathe, plain bed, swinging a fixed maximum diameter of 12 in., and having speeds up to 3,600 rpm, with flat belt cone drive for various speeds up to 3,600 rpm.

(b) One light spinning lathe, as above, having a swing up to 24 in. in diameter.

(c) One heavy-duty spinning lathe, having a 48 in. maximum swing and a gap of 24 in. deep. Lathe to be equipped with a heavy tailstock, a flat belt cone drive for the necessary speed changes, a heavy tee rest for support of the spinning tool and a swiveling tool post holder.

(d) Various spinning tools and chucks are illustrated on the tool chart.

(e) Small tool repair shop, consisting of hand grinder, polishing and honing tools, and drum with coolant used to reduce friction on the tools.

Financial and Manpower Summary:

Cost of equipment, described above, including countershaft drive with cone pulleys for necessary speed changes, and sufficient tooling to produce a large number of shapes is as follows:

(a)	One light spinning lathe, as described on the previous page....	$ 1,200.00
(b)	One light spinning lathe, with a swing over bed of 24 inches...	1,800.00
(c)	One heavy duty spinning lathe, as described.....	2,600.00
(d)	Various tools, as shown.....	300.00
(e)	Tool care and maintenance equipment.....	500.00
(f)	Clearing tank to remove oil spots from workpieces.....	200.00
(g)	Drums of coolant.....	50.00
	Total	$ 6,650.00

Manpower Requirements:

One supervisor who also serves as a spinner.....$4,000.00

Two spinners.....$7,000.00

One helper.....$2,500.00

In addition to the above purchase equipment costs, there are other expenses which should be considered, such as cost of foundation, building, installation, utilities, land improvement, insurance, and certain unpredictable factors which may add considerably to the total cost of getting the shop ready for operation.

Bibliography:

"Spinning Aluminum Alloys," Sheet Metal Industry, Jan. 1954, 49 Wellington Street, London W.C. 2, England. Presenting the fundamental concepts of the art of spinning and its application to certain aluminum alloys.

"Basic Tooling for Spinning Metals," Tool Engineer, Mar. 1954, 10700 Puritan Avenue, Detroit 38, Michigan. Describes and illustrates spun work pieces and the special tools used; presents formulas for determining the sizes of the blank sheets and illustrates typical shapes made by spinning.

"Pre-Spun Increases Drop Hammer Production," Western Machinery and Steel World, Nov. 1953, 564 Market Street, San Francisco 4, California. Here is the case of a workpiece which is spun first into approximate shape, and the final contours obtained by forging. Increased economies are effected by this combination of two different processes.

"From Brown's Candlesticks to Stainless Venturi Nozzles," Western Machinery and Steel World, Dec. 1952. Describes and illustrates a new technique in high production of aircraft parts by improved spinning method.

"Spinning Non-Circular Aircraft Components," Machinery, Oct. 1953, 93 Worth Street, New York 13, N.Y. Not only complicated round, but also eccentric square and hexagon workpieces can now be shaped by a spinning method described and illustrated in this article.

"Some Examples of Metal Spinning," Machinery, Aug. 6, 1954., National House, West Street, Bright 1, London, England. Article explains how spinning increased shop production of difficult shapes in preference to other methods, and shows on several workpieces how extreme deformities are possible by spinning.

Catalogs:

Excellent summaries of the technique of spinning are given also in the following catalogs:

"Aluminum Forming" by Reynolds Metals Co., Louisville, Kentucky. Form RMC-6.
"Forming Alcoa Aluminum" by Aluminum Co. of America. Form No.Ad-130. Pittsburgh, Pa.
"Forming and Bending." by Kaiser Aluminum and Chemical Sales Co., Inc. 919 North Michigan Boulevard, Chicago 11, Illinois
"Spinning Machines and Spinning Tools" by E.W. Bliss Co., Brooklyn, N.Y.
"Spinning Machines and Tools" by Lodge Shipley Manufacturing Co., Cincinnati, Ohio.
"Spinning Machines" Special Designs by Cincinnati Milling Machine Co., Cincinnati, Ohio

Mention of the name of any firm, product or process in this report is not to be construed as a recommendation or endorsement but merely as a citation that is typical in its field. Commercial directories generally list names of additional companies and products.

NOTE: To obtain copies of any catalogs, bulletins and other reference material mentioned in this report, please write direct to the indicated source of issue or supply.

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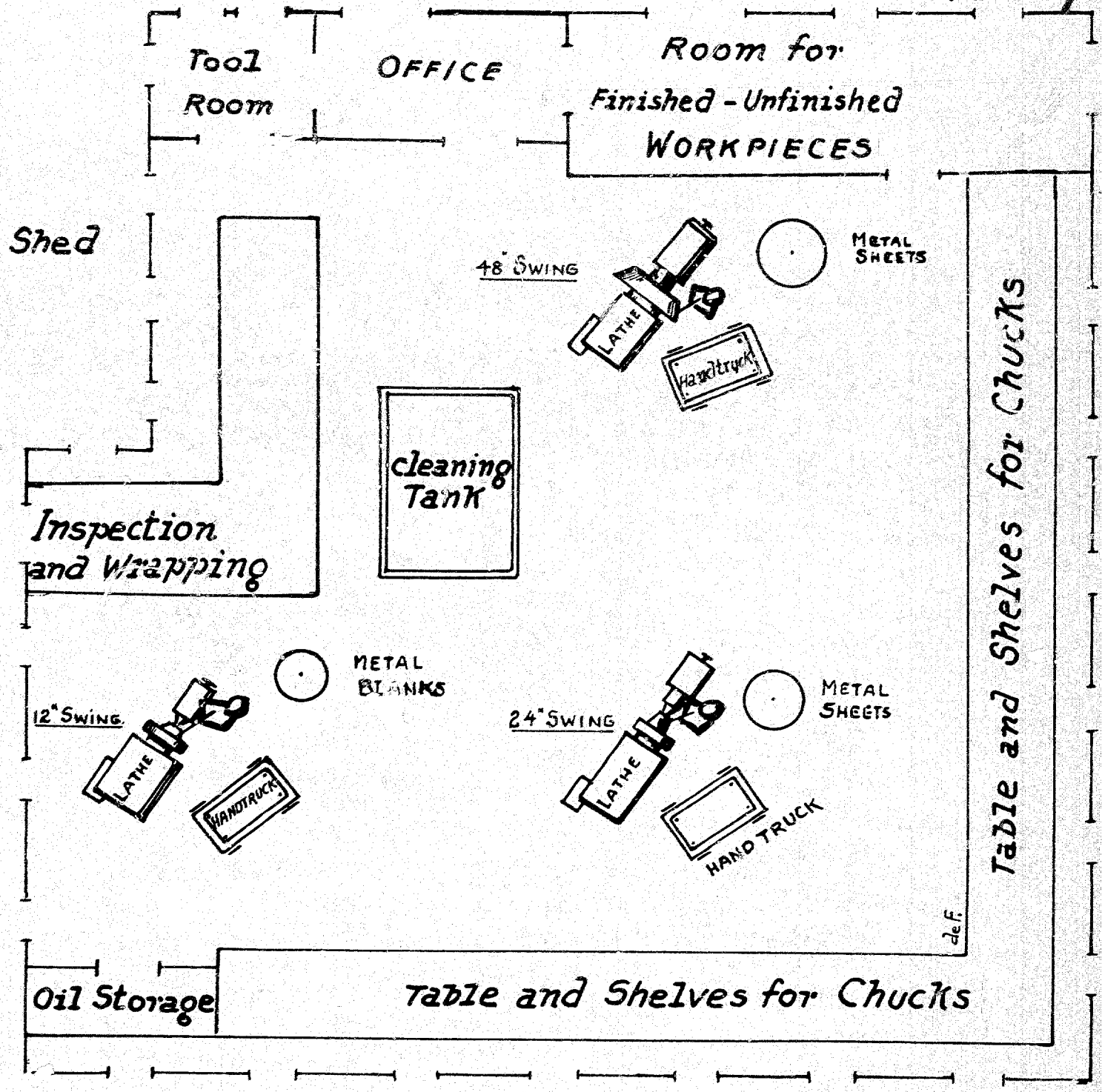

METAL SPINNING SHOP

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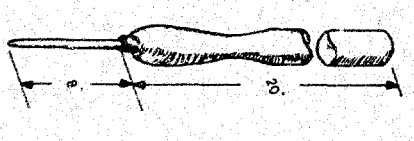
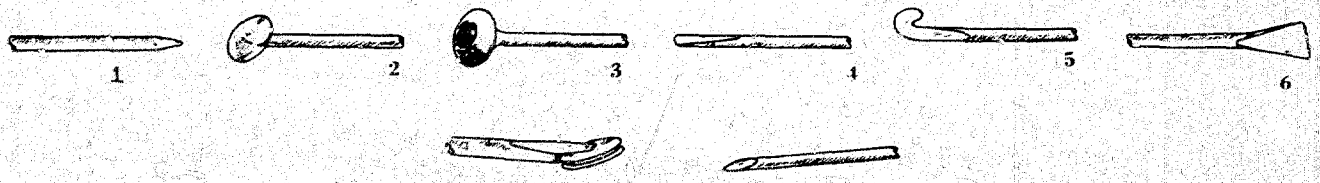
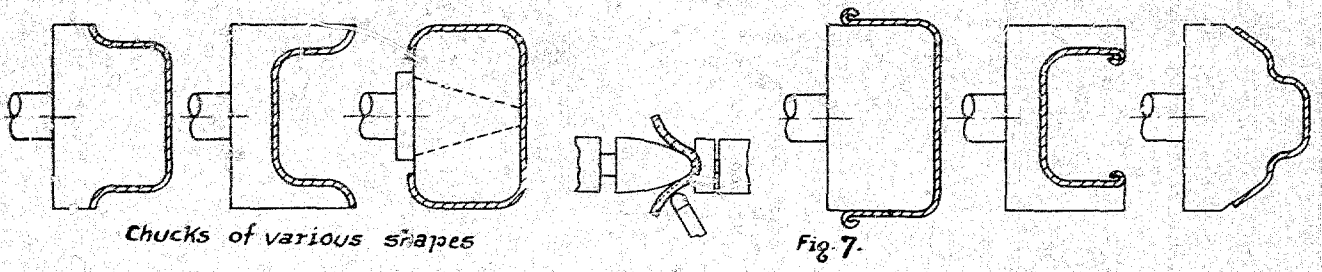
METAL SPINNING TOOLS & PROCESSES



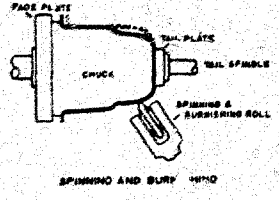
Spinning Tools Are Made to Fit the Job





Chucks of various shapes

Fig. 7.



SPINNING AND BURNISHING

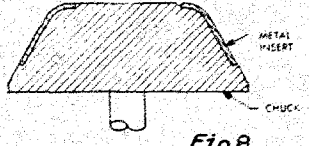
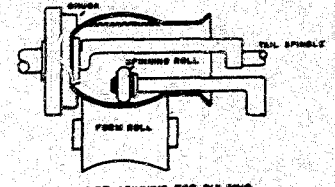
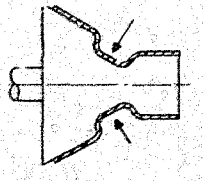


Fig. 8



INSIDE SPINNING FOR BULGING

Fig. 10



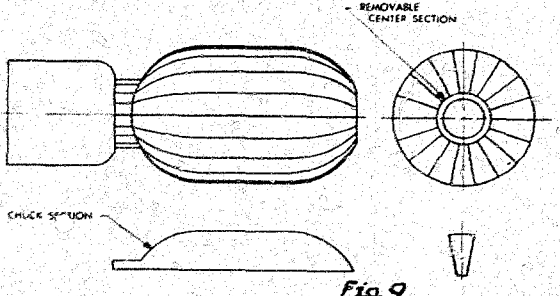
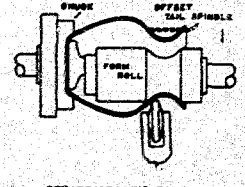
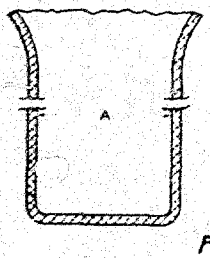


Fig. 9



OFFSET SPINNING FOR NECKING



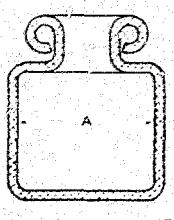


Fig. 11

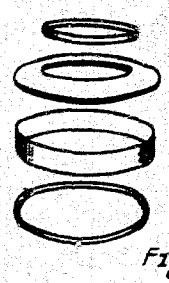


Fig. 12

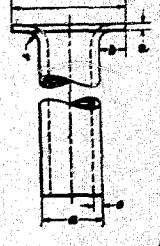


Fig. 13